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Determined were the functional design requirements of two components of an information system, the request-receiver and request-processor. The participants were 46 university biological scientists in the Washington, D.C. area who agreed to place requests by telephone with a specially established clearinghouse. A trained, experienced biological scientist served as one type of receiver-processor. The other receiver-processor was a receptionist without training or experience in the biological sciences. The requesting behavior of participants with the two types of request-receivers and request-processors was analyzed. Results indicated that (1) importance of technical feedback between receiver and requester depends on the nature of the request, (2) the time spent in processing the requests was about the same for both types of processors, (3) user evaluations of clearinghouse output indicated that the receptionist and scientist functioning in the role of receiver-processor performed equally well, (4) the impact of refinements provided by the scientist-processor on the product of the information system appeared to be minimal, and (5) lack of familiarity with scientific terminology did prevent the receptionist from handling some requests received. A complete description of the operation is provided. (DS)

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Science Information Requirements of Scientists: The Need for a Scientific Request Receiver and Processor in an Information Clearinghouse

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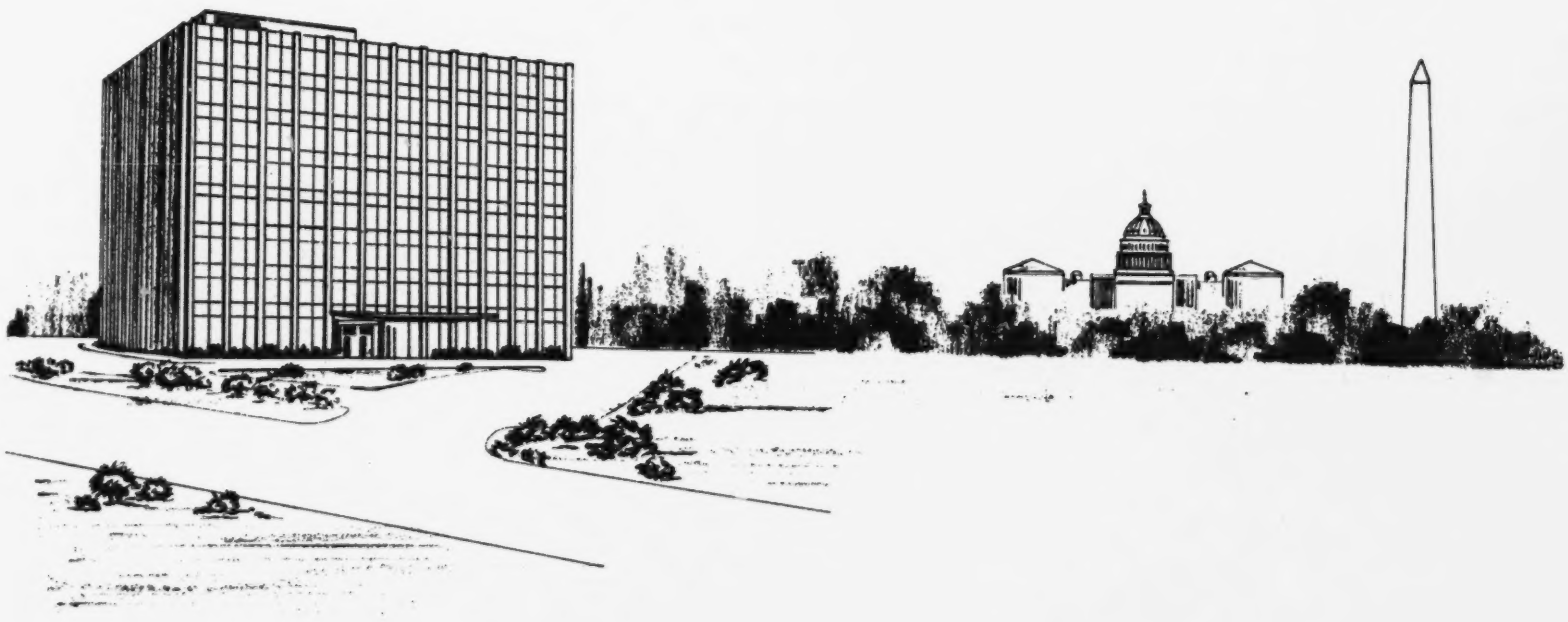

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TECHNICAL REPORT NUMBER 2

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FOREWORD

The investigation described in this report was supported by the National Science Foundation, Contract Number C 492, with Mr. Richard See serving as the NSF Scientific Officer.

As part of the project described in this report, an Information Clearinghouse was established at the Federation of American Societies for Experimental Biology. Dr. Beverly L. Clarke, Research Officer at the Federation, served as a Co-Principal Investigator on the project, and was responsible for organizing and operating the Clearinghouse. Working with Dr. Clarke were Dr. Henry Stevens, recently retired as Chief Biochemist, Allergens Laboratory, U. S. Agricultural Research Service, and Mrs. Grace Gurtowski, previously with the Federation's Translation Project. Also, assisting on a part-time basis were Mrs. Ruth Katz, Science Division of the Library of Congress, and Mrs. Ruth Stander, formerly with the National Cancer Institute.

M. G. Fromm, G. R. Wheaton, Cathy B. Judd, and W. P. Gloege contributed to various phases of this study.

In addition, the cooperation of the biological scientists who participated in this study is gratefully acknowledged.

ABSTRACT

The purpose of this study was to assess functional design requirements of two components of an information system, the request-receiver and request-processor. Forty-six biological scientists working at universities in the Washington, D. C. area agreed to participate and were invited to place requests by telephone with a specially established clearinghouse. The requesting behavior of participants with two types of request-receivers and request-processors was analyzed.

A trained, experienced biological scientist served as one type of receiver and processor. The other sort of processor and receiver was represented in this study by a receptionist without training or experience in the biological sciences. Both types of receivers supplied feedback (technical and/or conversational, according to their abilities) directly to scientists as they were making requests. Participants were provided with a schedule each week during the six-week study period indicating which type of receiver would be available mornings and afternoons during the week.

Clearinghouse operation, beginning with the scientist requesting information and continuing through his receipt of the system's end product, is described. In addition, the scientists' evaluations of the information output produced by the clearinghouse and its operation were analyzed and are reported.

The importance of technical feedback between receiver and requester in an information system is seen to depend on the nature of the request. Research results indicate that a scientist placing a well-formulated and structured request does not find it necessary to consult with a source knowledgeable in the subject matter of concern. On the other hand, a preference was shown for the scientist-receiver when a request involved a bibliographic search rather than retrieval of a specific document.

The time spent in processing requests was about the same for both types of processors, although this time was spent in different ways by the two. User evaluations of clearinghouse output indicated that the receptionist and scientist functioning in the role of request-processor performed equally well. The impact of refinements provided by the scientist-processor on the product of the information system appeared to be minimal. These findings would indicate that rather simple design features are required for a request-processor in an information clearinghouse. Lack of familiarity with scientific terminology did prevent the receptionist from handling some requests received; more complex features are thus essential to ensure the processing of these requests.

INTRODUCTION

Throughout the scientific community there is a growing interest in designing and implementing automatic information systems because of the remarkable advancement in computer and information science technology. Specifically, computers have the capability to store a large number of data or document collections. Procedures are available for analyzing and organizing this information and insuring that the stored information is retrieved in response to requests from a specified user population (Rubinoff, 1965; NINDB, 1966; & Schecter, 1967).

Before this technology can be effectively applied to automated information services, it is necessary to determine which of many possible alternative design features should, in fact, be implemented (Salton & Lesk, 1967). One pressing design issue concerns the interface between the requester and the other elements of the system.

Among the many different devices a requester could use to gain access to an information system, is for example, a direct interface by way of Touch-Tone telephones, or with teletypewriter keyboards (Overhage, 1966). The requester simply inputs his request and waits for other elements in the system to respond. Swanson (1964), on the other hand, views the interface as a console which permits successive "programmed interrogations", where a dialogue between the requester and the console produces a product that comes increasingly nearer to fulfilling the requester's information requirement. Each of these concepts has different design and cost implications, and each imposes different user constraints. This report attempts to establish some of the functional requirements for an interface between requesting biological scientists and an information system.

In a previous study (Kinkade & Van Cott, 1967), biological researchers were asked to express their opinions about the requirements of a request-receiver. Almost universally they indicated that it was important to them to have an intelligent, responsive and trained person receive and process their requests. A fellow biological scientist could enter into a dialogue which would facilitate the request formulation and then his training would be invaluable for processing the requests they felt. However, when these scientists actually used such an information system that had been established for them, they generally made highly specific and well-formulated requests. The trained biological scientist who served as a request-receiver did not feel that his training was particularly useful in processing most of the requests. The results of this study raised several questions concerning the requirements for a device serving as an interface between requesting scientists and other elements in the information system. Specifically, should the device be designed so that it could help the scientists formulate their requests? Would the scientists use the information system if they felt that they had to have a well-formulated request before they could contact the system? Are the training and background of an experienced scientific researcher essential for effective processing of scientists' requests?

To investigate design requirements for an interface between requesting biological scientists and an information system, a clearinghouse was established at the Federation of American Societies for Experimental Biology. Biological scientists were invited to call the clearinghouse on the telephone without restraints being placed on them with respect to the number or type of requests that they could make. They were told that either a trained biological scientist or an untrained receptionist would receive their requests and they were given a schedule indicating when each request-receiver type would be available to receive their calls. After a request was received, it was processed

by either the scientist or the receptionist. Other elements in the system then filled the request, and the system product was sent to the requesting scientist who was then asked to evaluate the ability of the system to fulfill his request.

Two interface components were evaluated in this study -- the request-receiver component and the request-processor. When the experienced biological scientist served as a request-receiver, he was able to carry on an active dialogue with the requesting scientist. If he detected ambiguities in the request, he could ask for clarification. For example, if the request appeared to cover a broad subject area, the trained request-receiver could ask the requester to delineate his area of interest more specifically. In addition, the trained request-receiver was able to understand the scientific terminology used by the requester and did not have to ask the requester to use a restricted vocabulary or restate the request. On the other hand, when the receptionist served as a request-receiver, the request was merely received as stated. The receptionists' primary job, then, was to only insure that the request as stated was comprehensible.

When the trained biological scientist served as the second interfacing component, the request-processor, he was able to specify terms and descriptors that were appropriate but were not stated in the requests. In addition, he was able to indicate likely sources for the materials, and to place appropriate constraints on search and retrieval activities needed to fill the requests. When the receptionist served as the request-processor, the requests could only be summarized before being given to the search and retrieval elements.

The functional design requirements of these two interface components, the request-receiver and the request-processor, were evaluated by analyzing the requesting behavior of the participating

scientists and their assessments of the products supplied by the clearinghouse. It was hypothesized that the requesting scientists would (1) direct most of their requests to the trained biological scientist, using the receptionist only for minor, well-formulated requests, and (2) be more satisfied with products resulting from the requests processed by the scientist than those resulting from the requests processed by the receptionist.

METHOD

Research Setting. The study was conducted in the Washington, D. C. area at an information clearinghouse located at the Federation of American Societies for Experimental Biology at 9650 Wisconsin Avenue, Bethesda, Maryland. Although the activities of the clearinghouse were adjunctive to the principal activities of other Federation members, a spirit of cooperation and interchange did exist between the two groups of personnel, and because of the reservoir of scientific knowledge at the Federation, the clearinghouse was able to be more responsive to a wider variety of requests.

Subjects. Biological scientists working at three universities in the Washington area were solicited. Those from a previous study were asked to supply names of potential candidates who were then contacted personally and asked to participate. Those willing to do so were asked to sign a statement indicating an awareness that their conversation would be recorded when they called the clearinghouse. Forty-six scientists agreed. Of these, 15 had been previous participants.

Procedure. The participating scientists were told that their requests would be received by one of two types: either by an experienced biological researcher or by a receptionist who had no training in the biological sciences. At the beginning of each week, the scientists were given a written schedule indicating when each request-receiver type would be available.

Participating scientists made requests by telephoning the clearinghouse. During the mornings of the first, third, and fifth weeks, and the afternoons of the second, fourth, and sixth weeks of the clearinghouse's operation, the request-receiver was a trained, experienced biological scientist who possessed a Ph. D. degree in biochemistry and had spent over twenty years actively engaged in biological

research and in the direction of a variety of government research projects. During the mornings of the second, fourth, and sixth weeks and the afternoons of the first, third, and fifth weeks of operation, the request-receiver was a female receptionist, completely untrained or inexperienced in any field of biological science. The request-receiver's task was to make certain that an understandable, processable request was made. Interaction, in the form of questions or the repetition of phrases to the requester, occurred primarily when the requests were not processed as stated or when some degree of confirmation from the requester was necessary. All of the requests were recorded on a tape-recorder.

At the completion of each call, the requests that were made during that call were processed by the request-processor. In this study, both the scientist and the receptionist functioned in the role of request-processors. The scientist processed half of the calls that he received and half of the calls that the receptionist received. Similarly, the receptionist processed half of the calls that the scientist received and half of the calls that she received. The request-processor listened to the taped recording of the call and summarized each request made during the call. In some cases, the request-processor interpreted the requests, adding descriptors or placing constraints on requests so that the requested information could be more effectively obtained.

The summarized requests, as interpreted by the request-processor, were then given to a search-strategist, who was a highly qualified librarian with a Bachelor of Science degree in biology. The search-strategist decided how the requests were to be filled and supplied any additional descriptors or constraints not included in the original requests. In some cases, a literature search was required. In either case, the search-strategist had to decide which of several available sources to use for filling the requests.

When the requests involved searching for information, the summarized requests were given to an information-searcher, along with any additional descriptors supplied by the search-strategist. Three information-searchers were employed on a part-time basis, their task being to locate required information by using existing library facilities.

When the information needed to fill a request was obtained by the clearinghouse, it was logged there and then delivered to the requesting scientist by messenger. Accompanying each document sent to the scientist was a Scientist Evaluation Sheet, containing four questions. The first question concerned the document's responsiveness to the scientist's request. The second question concerned possible additional information needs of the scientist resulting from the product supplied by the clearinghouse. The third concerned the acceptability of the time delay needed to fill the request. The fourth question asked for an overall evaluation of the service in light of that particular request.

The participating scientists were interviewed periodically in a brief and informal manner in order to obtain whatever insights and evaluations they could supply concerning the clearinghouse's operation and to ascertain whether or not they actually did consult the request-receiver's schedule. The complete cycle of the clearinghouse's operation is illustrated in Figure 1.

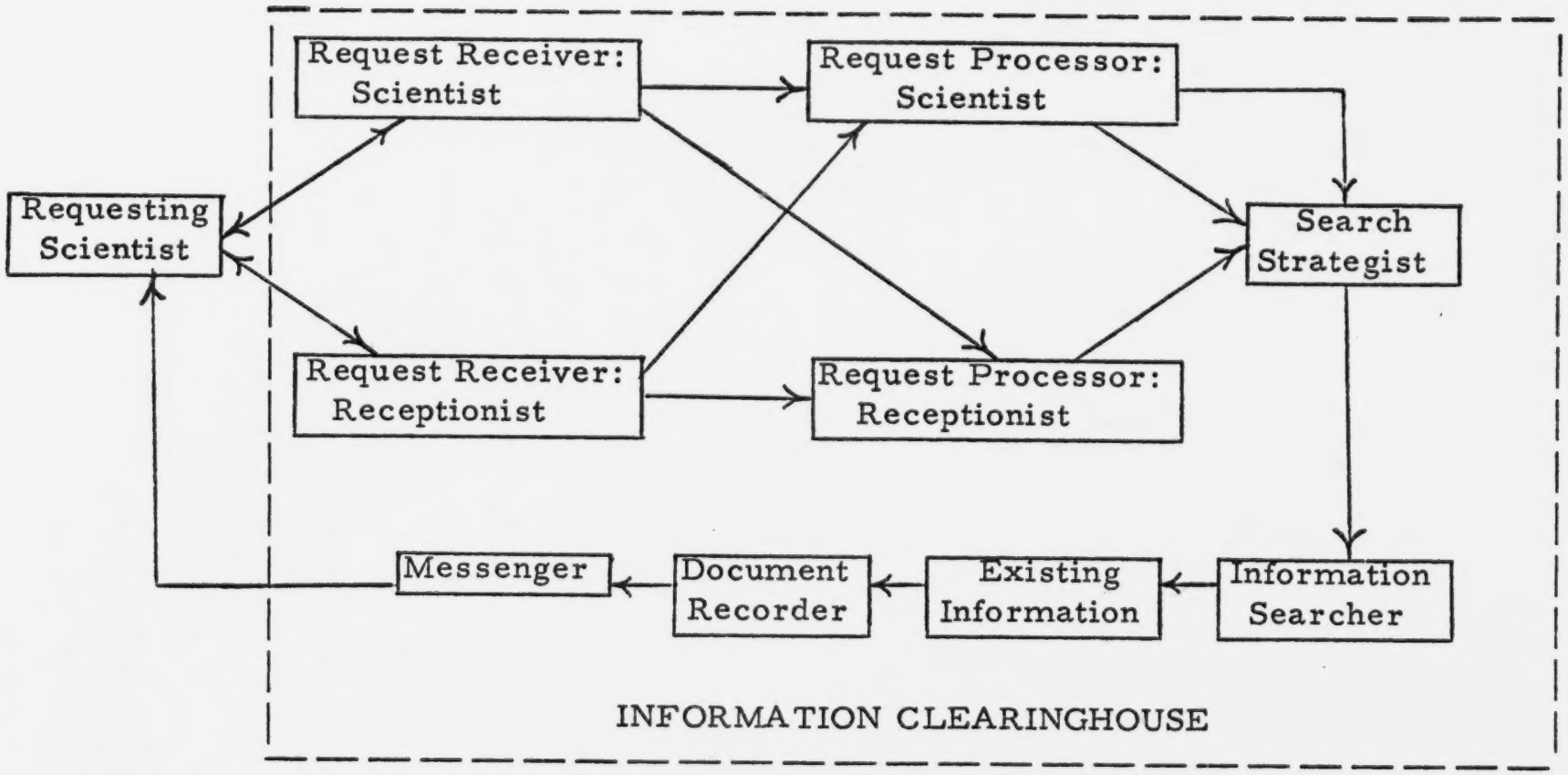

Figure 1. Representation of the FASEB Information Clearinghouse System for the Scientist/Receptionist Study

RESULTS

The question concerning use of a trained biologist as a request-receiver and as a request-processor was evaluated by means of the scientists requesting behavior and assessments of the products supplied. Results are presented under five headings. The first section deals with a description of the general participation of the scientists. The second section describes the Request Load, i. e., how many requests were made, when requests were made, and how many requests were made at one time. Request Content, i. e., what was asked for, how it was described and the subject of the requests, is handled in the third section. The fourth section, Request Processing, describes differences in processing the requests as a function of the processor and receiver used. The final section contains the Scientists' Evaluation of the clearinghouse.

A call was counted when contact was made by one of the requesting scientists to the clearinghouse. A request was any statement made by a scientist during a call to which the system could respond with a document. If several journal articles were requested during a call each of these was considered as a request. An inquiry for information on a given topic which resulted in a bibliographic search was also treated as a request.

Participation. Twenty-five of the 46 scientists who agreed to participate in the study actually placed calls. Almost half of these (12) called the scientist-receiver exclusively. The receptionist-receiver was used exclusively by about $\frac{1}{4}$ of the scientists and the remaining $\frac{1}{4}$ used both request-receiver types. The scientists placed a total of 53 calls to the clearinghouse. Figure 2 shows the cumulative number of calls placed to each receiver type as a function of the number of days of clearinghouse operation. After a slow start, the two curves separate

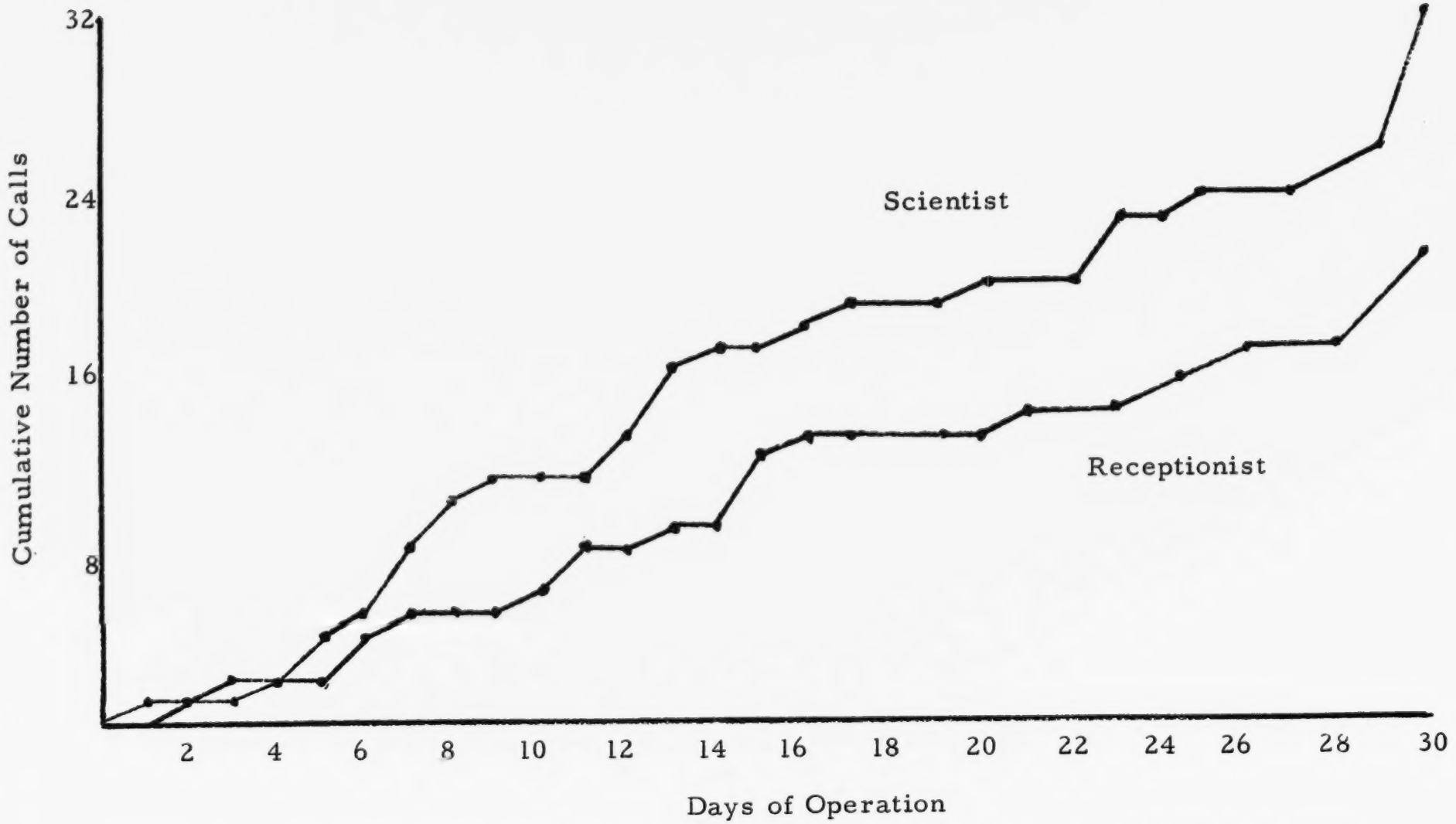

Figure 2. The cumulative number of calls to each receiver type as a function of days of operation.

and then tend to parallel one another. The total number of calls to the scientist-receiver was 32 while 21 were directed toward the receptionist receiver. The range of calls per scientist placed to each of the receiver types was the same, 1 to 5 calls per scientist.

Request Load. During the six weeks of clearinghouse operation a total of 171 requests were made. Fifty-five percent of these were placed through the scientist-receiver. Table 1 contains a more detailed analysis of the request history, showing the number of requests directed to each request-receiver type by week and by day of the week.

Table 1

TIME HISTORY OF REQUESTS BY WEEK AND DAY AS RECEIVED BY THE SCIENTIST (S) OR THE RECEPTIONIST (R)

	MON.		TUES.		WED.		THURS.		FRI.		TOTALS	
WEEKS	S	R	S	R	S	R	S	R	S	R	S	R
I	2	0	0	2	0	9	1	0	9	0	12	11
II	1	8	5	5	4	0	6	0	0	1	16	14
III	0	4	4	0	6	7	5	0	0	18	15	29
IV	2	1	1	0	0	0	0	0	4	0	7	1
V	0	6	0	0	9	0	0	1	1	4	10	11
VI	0	1	0	0	1	0	2	2	31	9	34	11
TOTALS	5	20	10	7	20	16	14	3	45	31	94	77

This shows that the placement of requests to one receiver type as opposed to the other is highly variable. During one week (Week III) the receptionist received more calls than the scientist and during another week (Week IV), the opposite was true. These differences, however, can usually be attributed to the requests for one day during that week. The scientist received more requests on each day of the

week during four of the five days. The high number of requests to the scientist on Friday and during the last week of operation is probably attributable to the last day of the clearinghouse's operation. The scientist was scheduled to receive during the afternoon and thus, was on duty during the closing hours of operation.

Figure 3 shows the total number of requests handled by each receiver type during various hours of the day. There are no differences for five of the seven hours. The hours of 2-3 P. M. and 3-4 P. M. do reflect a difference between the two receiver types. The higher number of requests handled by the scientist from 2 P. M. to 3 P. M., however, seems to be due to the calls received on the last day of operation. The greater number of requests placed with the receptionist between 3 P. M. and 4 P. M. seems to be evenly distributed across weeks.

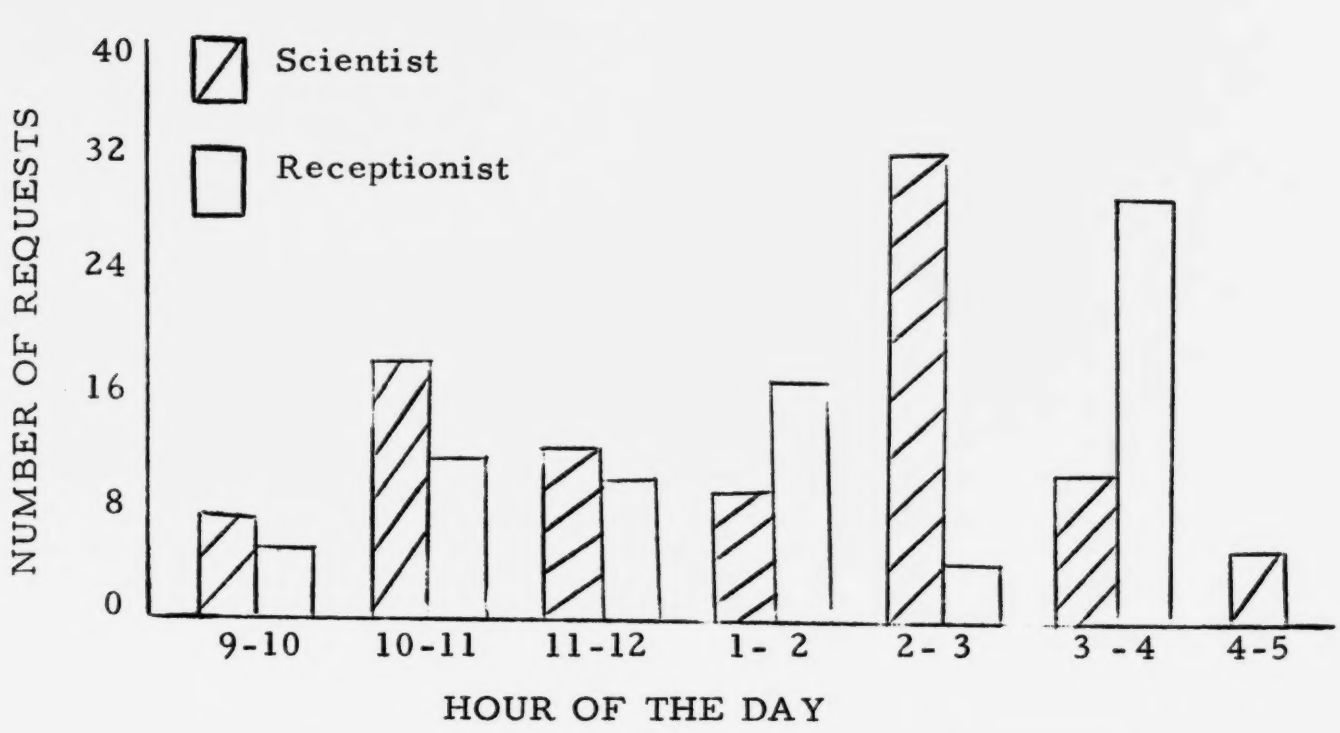

Figure 3. The Total Number of Requests Received During Each Hour of Operation by Each Receiver Type Summed for all Days.

Approximately 2/3 of the calls to the scientist and 1/2 of the calls to the receptionist were for one or two requests. The average number of requests per call to the scientist was 2.94 and to the receptionist, 3.67.

Request Content. Requests were broadly categorized as those requiring a copy of an article (document request) or those requiring a search of the literature for references on a given topic (bibliographic search request). About 2/3 of all the requests were for copies of documents or parts of documents. Of these document requests, about half were received by the receptionist. About 3/4 of the search requests, however, were placed with the scientist.

If one poses the question as to which receiver type the scientist will choose to call, given that he has a certain kind of request to make, the data may be analyzed in terms of conditional probabilities. Given that the requester wishes a document, there is roughly an equal probability of choosing either receiver type (.52 for the scientist, .48 for the receptionist). When a search request is to be made, there is a greater probability (.74) that the scientist will be called.

Request Processing. The time required to process requests was no different for the scientist or the receptionist. The scientist took an average of 9.61 minutes per request and the receptionist, 9.09 minutes. The breakdown for request processing according to the type of request also indicated no difference between processor types. It took the scientist about 17.02 minutes per search request and 5.65 minutes per document request. The receptionist handled search requests in an average of 15.68 minutes and document requests took her about 5.61 minutes to process.

However, these times are based on the calls actually processed by the scientist and the receptionist. The receptionist was unable to process four of the calls assigned to her. The principal problem that she had in processing these calls was an inability to comprehend words because of the requester's poor diction. The scientist, on the other hand, was able to process these calls with little difficulty.

Scientists' Evaluation. About 2/3 of the participating scientists' evaluations were returned. These evaluations of the end products indicated that 97% of the documents supplied by the clearinghouse were found to be responsive to the requests. There appears to be no difference in the type of processor used. Only 68% of the searches, however, were found entirely responsive to the requests. Roughly half of the requests handled by the scientist as both receiver and processor and half of the requests handled by the receptionist as both receiver and processor were rated as being partly non-responsive. Thus, there appears to be no difference in the responsiveness of the end product as judged by the requesting scientists.

Over 1/3 of the scientists who were interviewed about the clearinghouse operations said that they consciously placed their calls to the biological scientist and a little less than 1/2 stated that they called at random; one requester called the receptionist specifically. The remaining scientists felt that placement of a request to one receiver type or another was dependent upon the nature of the request.

DISCUSSION

That it is important to be able to carry on a dialogue with the request-receiver was not conclusively demonstrated by the total number of calls directed toward the two request-receiver types. The difference in the total number of calls placed was not significant, although the scientist-receiver did tend to receive more calls. A tendency for the scientist to be selected appeared to become stronger toward the end of the six week period. This could be because of the particular request-receiver schedule used in the study, rather than an indication of preference.

The scientist receiver was preferred by the scientists, however, when their request involved a search. A significantly greater number of search requests were placed through the scientist-receiver, whereas document requests were placed about equally to either type of request-receiver. This might be interpreted as an expression of the need to consult with a knowledgeable source when making an unstructured request. Search requests seem to need some amount of clarification in terms of adding descriptors or narrowing the area of the search. A request for a specific document, on the other hand, is usually very specific and structured (Kinkade & Van Cott, 1967).

On the basis of these results, it can be concluded that the importance of being able to discuss a request with a request-receiver in an information system is dependent upon the nature of the request. This feature will not be required when they are placing a well-formulated, structured request. However, when the request is less specific, the requesting scientists will make a conscious effort to place their requests with a responsive request-receiver.

With respect to the features of the request-processing component, it appears that the scientist-processor and receptionist-processor function equally well in terms of the requesting scientists' evaluation of the product supplied by the system. The other elements in the information system apparently respond to gross aspects of requests, and minor refinements added by the scientist-processor have very little effect on the product supplied by the system.

Although a nearly equal amount of time was spent in processing requests by the two processor types, it was spent in a different way. The scientist-processor spent his time in adding descriptors and indicating likely sources of material needed to fill the requests. The receptionist-processor spent her time in consulting a dictionary of biological terms so that she could accurately note the descriptors contained in the requests. As stated previously, the impact of the refinements added by the scientist-processor on the product supplied by the system appeared to be minimal.

It should be noted, however, that the receptionist-processor was unable to process some of the requests. Her failure to be able to perform was directly attributable to the fact that she could not understand the requesting scientists' oral pronunciation of scientific terms sufficiently well to locate them in a dictionary. The scientist-processor, on the other hand, could extract enough information from other parts of the requests to have no trouble defining words that were poorly articulated.

This study has demonstrated that relatively simple design features in two interface components of an information system, the request-receiver and the request-processor, will be acceptable to biological scientists for some of their requests. When the requests are well-formulated and structured, and when the terms used in the request

are clearly understood, simple request-receiver and request-processor components are sufficient. However, more complex design features are required in both components to handle all of the requests that biological scientists are likely to make. Requesting scientists prefer to discuss their requests with the request-receiver when the requests are not for specific documents, and the ability to deduce certain poorly articulated terms from the information contained in a total request is essential to process all of the requests.

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